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Raptor and Chihuahuan Raven Nesting on Decommissioned Telephone-line Poles in the Northern Chihuahuan Desert

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Abstract.—White Sands Missile Range (WSMR) in south-central New Mexico includes ca. 800 000 ha of northern Chihuahuan Desert, where little is known regarding raptor and Chihuahuan Raven (*Corvus cryptoleucus*) nesting. We studied 338 decommissioned telephone-line poles with 22 different cross-arm configurations and six electrical poles in 10 vegetation cover types from 29 March–14 September 1997. We encountered 64 Chihuahuan Raven nests on decommissioned telephone-line poles. We found 27 Swainson's Hawk (*Buteo swainsoni*) nests, most often on a configuration with two vertical poles supporting four paired sets of cross-arms. Using a geographic information system analysis, we found Chihuahuan Raven nests similarly distributed in all vegetation cover types, while honey mesquite (*Prosopis glandulosa*) desertscrub covered a mean of 64.2% of the area within 3 km of each Swainson's Hawk nest. Decommissioned telephone-line poles benefit raptors and Chihuahuan Ravens as nesting platforms, and should be managed and retained where possible in the southwest. We suggest that pole salvage operations in the northern Chihuahuan Desert should retain poles with at least two sets of paired cross-arms, which are suitable raptor and raven nesting sites. For management of Swainson's Hawks, configurations with two vertical poles supporting four paired sets of cross-arms seemed most suitable in the area we investigated.

Key Words: *Swainson's Hawk*; Buteo swainsoni; *Chihuahuan Raven*; Corvus cryptoleucus; *Chihuahuan Desert*; *GIS*; *nest habitat*; *nest structure*; *poles.*

ANIDACION DE RAPACES Y DEL CUERVO DE CHIHUAHUA EN POSTES DE LINEAS TELEFÓNICAS DESCONTINUDAS EN EL NORTE DEL DESIERTO DE CHIHUAHUA

Resumen.—La zona de prueba de misiles de White Sand (WSMR) en el centro-sur de nuevo México incluye ca. 800,000 ha del norte del Desierto de Chihuahua, donde es poco se lo que se sabe sobre la nidación de rapaces y del cuervo de Chihuahua (*Corvus cryptoleucus*). Estudiamos 338 postes de líneas telefónicas descontinuadas con 22 configuraciones con estructuras cruzadas (X) diferentes y seis postes eléctricos en 10 tipos de cobertura vegetal, desde el 29 de Marzo–14 Septiembre 1997. Encontramos 64 nidos de cuervos de Chihuahua en postes de líneas telefónicas descontinuadas. Encontramos 27 nidos de halcones de Swainsoni (*Buteo swainsoni*), la mayoría a menudo, en una configuración con dos postes verticales soportando 4 pares de sets de cruces (X). Usando análisis de sistema de información geográfica, encontramos nidos de cuervos de Chihuahua similarmente distribuidos en todos los tipos de cobertura vegetal, mientras que *Prosopis glandulosa* cubrió una media de 64.2% del área de 3 km de cada nido del gavilan de Swainsoni. Los postes de líneas telefónicas descontinuados benefician a las rapaces y a los cuervos de Chihuahua ya que sirven como plataformas de anidamiento y deberían ser manejadas y retenidas/mantenidas donde sea posible, en el suroeste. Sugerimos que operaciones de postes silvestres en el norte del Desierto de Chihuahua deberían retener/mantener postes con al menos dos sets de cruces (X) pareados, los cuales son sitios de anidación apropiados para rapaces y cuervos. Para el manejo del gavilan de Swainsoni, configuraciones con dos postes verticales soportando cuatro sets pareados de cruces (X), parecieron ser más apropiados en el área que investigamos.

[Traducción de César Márquez]

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Few investigators have examined raptor and raven nesting on artificial platforms in northern Chihuahuan Desert vegetation cover types. During a 3-yr study in southern New Mexico, Kimsey and Conley (1988) found desert, irrigated agricultural, and riparian areas with power-transmission-line support poles received more use by raptors than similar areas devoid of poles.

Other studies have described raptors nesting on natural substrates in southern New Mexico. Pilz (1983) found Swainson's Hawks (*Buteo swainsoni*) in southern New Mexico nesting in grasslands on soaptree yuccas (*Yucca elata*). England et al. (1997) described this hawk as nesting in scattered trees in grasslands, shrublands, and agricultural areas occasionally, with some nests used more than 1 yr. Bednarz and Hoffman (1988) found Swainson's Hawks nesting in large honey mesquite (*Prosopis glandulosa*) and soapberry trees (*Sapindus drummondii*) dispersed over a landscape covered by honey mesquite, shinnery oak (*Quercus havardii*), sand sage (*Artemisia filifolia*), snakeweed (*Gutierrezia sarothrae*), and creosotebush (*Larrea tridentata*) in southeastern New Mexico. Eleven nests of Chihuahuan Ravens (*Corvus cryptoleucus*) and one Swainson's Hawk nest in southeastern New Mexico were in mesquites taller than surrounding vegetation (Griffing 1974, Davis and Griffing 1977). Bednarz and Raitt (2002) described this raven as nesting in various shrubs and trees in grasslands, shrublands, and woodlands, and on human-made structures including poles.

Raptor and raven nesting ecology, on artificial and natural substrates, has been studied extensively in other regions of North America. Steenhof et al. (1993) monitored progression of use by Common Ravens (*Corvus corax*) and raptor species on newly erected power-line-transmission towers in Idaho and Oregon. In the area of these towers, nesting pairs of Common Ravens, Golden Eagles (*Aquila chrysaetos*), Red-tailed Hawks (*Buteo jamaicensis*), Ferruginous Hawks (*Buteo regalis*), and Great Horned Owls (*Bubo virginianus*) increased during the 9-yr study. In that study, nesting pairs of raptors and Common Ravens gradually abandoned nearby natural nesting substrates and began nesting on the available towers.

Bechard et al. (1990) found Red-tailed Hawk, Ferruginous Hawk, and Swainson's Hawk nesting substrates in Washington included cliffs, transmission-line towers, windmills, and trees. Red-tailed Hawks nested closest to water, primarily in the tallest and oldest trees, and in areas with large amounts of shrub and grassland habitat. Swainson's Hawks nested entirely in trees close to roads and human structures; nearly half of the nests were in areas where the surrounding habitat was dominated by wheat fields. This is consistent with Bednarz' (1988) investigation of breeding ecology of Swainson's Hawks in southeastern New Mexico, where grasses were a key component among the nest habitats of this species.

White Sands Missile Range (WSMR) in south-central New Mexico represents an ecologically significant portion of northern Chihuahuan Desert because of restricted access and relatively low disturbance compared to outside the WSMR boundary. The northern Chihuahuan Desert within WSMR has been devoid of agricultural activity including livestock grazing for over 50 years. Additionally, other anthropogenic developments such as buildings and associated infrastructures are limited and confined to isolated areas throughout WSMR.

WSMR contains numerous decommissioned telephone-line poles and active electrical-transmission-line poles, each consisting of a variety of configurations among several vegetation cover types. A pole configuration consists of one to several vertical poles supporting one to several paired or unpaired cross-arms. The telephone-line poles present in 1997 were retained during WSMR-wide pole removal in the early 1990s. Retained poles were those that contained a nest structure during pole removal operations and ca. 10% of other poles that had paired cross-arms, regardless of presence of a nest structure. We investigated decommissioned telephone-line poles to assess use of these structures by nesting raptors and ravens on WSMR. Using a geographic information system, we described the vegetation cover types around each decommissioned telephone-line pole.

STUDY AREA

WSMR is a military and space systems test and evaluation facility operated by the U.S. Army. Located in south-central New Mexico, WSMR encloses ca. 8000 km^2 of the northern Chihuahuan Desert. Topography of WSMR includes portions of the Tularosa Basin, the Jornada del Muerto, and several mountain ranges. The WSMR portion of the Tularosa Basin contains extensive gypsum dunes, lava beds, level to rolling grasslands, small marshes, and salt flats. Vegetation includes vast patches of honey mesquite, creosotebush, four-wing saltbush (*Atriplex canescens*), and grasslands of a variety of species (Dick-Peddie 1993). The Jornada del Muerto of WSMR

includes extensive patches of grasslands, honey mesquite, sand sage, and creosotebush.

Two prominent mountain ranges exist on WSMR. The San Andres Mountains dominate the west central portion of WSMR, while the Oscura Mountains dominate the northeast. High elevations of both ranges are covered with pinyon pine (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*). The rocky slopes and cliffs of both ranges are covered with mountain mahogany (*Cercocarpus montanus*) and piedmont grasslands that give way to level and rolling topography of the Tularosa Basin and Jornada del Muerto.

Weather conditions over the time of this investigation (29 March–14 September 1997) were compiled from 19 surface atmospheric monitoring stations throughout WSMR. Mean monthly precipitation throughout lowland portions of WSMR, where most decommissioned poles exist, was 3.17 cm. Maximum temperature was 44°C and minimum temperature was −6°C. Mean temperature over a 24-hr period during this investigation was 19°C. Mean wind speed throughout WSMR was 14 km/hr with peak gusts of 174 km/hr in the Jornada del Muerto and 163 km/hr in the Tularosa Basin. These were typical weather conditions on WSMR.

Developed areas of WSMR are largely limited to clusters of one to three buildings distributed throughout the range. Historically, the area that is now WSMR contained several cattle, goat, and sheep ranches. However, ranching was terminated when WSMR was officially established in 1945. Since then, grazing has been limited to feral horses and gemsbok (*Oryx gazella*), an African antelope, introduced in the late 1960s. The landscape within WSMR is minimally disturbed, as impacts of weapons and missile testing over the last 50 yr have been limited to specific areas.

METHODS

Pole Examination. All decommissioned telephone-line poles within WSMR were located using maps of the telecommunications network, or were found while conducting other investigations. Decommissioned telephone-line poles in areas of highly-restricted access (bombing, and air-to-ground gunnery ranges) on WSMR were not examined. Fewer than eight poles were known to exist in those areas.

Locations for all poles were collected with a global positioning system (GPS) receiver and differentially corrected to UTM coordinates (datum = NAD83). Poles were examined by traveling maintenance access roads that paralleled a line of poles. Pole configurations were characterized by the number of poles supporting a number of paired or unpaired cross-arms (Fig. 1). For example, a pole configuration could include two vertical poles supporting four paired or parallel cross-arms. Cross-arms were numbered from the top down on all poles.

Decommissioned telephone-line and electrical poles were examined from 5 April–2 July 1997. If a pole had an occupied raptor or raven nest, the species and date were noted and the pole was revisited during August–September 1997 to measure pole characteristics after the young had fledged.

A compass was used to collect a bearing of the long axis of cross-arms on each pole to determine pole orientation. Pole orientation was used to determine nest exposure (placement of the nest on cross-arms relative to exposure to wind and solar radiation). This measurement was taken to investigate whether raptors or ravens nested on a specific side of a vertical pole relative to the pole's orientation. The bearing was taken in the direction the nest received the most exposure.

Heights of pole features were measured with a telescoping fiberglass rule to the nearest centimeter. Cross-arm heights, distances between cross-arms, distances between the top of the nest and underside of the above cross-arm, and pole heights were measured only on those decommissioned telephone poles with occupied and unoccupied nests. Herein, decommissioned telephone-line pole configurations are identified using the number of vertical poles and the number of paired cross-arms. For example, a single vertical pole supporting four sets of cross-arms is denoted as a 1X4.

Vegetation Characterization. Vegetation cover types within a 3-km radius of each pole were identified using a GIS. These cover types included arid grasslands dominated by blue (*Bouteloua gracilis*), hairy (*B. hirsuta*), and black (*B. eriopoda*) grama, mesa dropseed (*Sporobolus flexuosus*), giant sacaton (*Sporobolus wrightii*), and tobosa (*Pleuraphis mutica*); shrublands dominated by four-wing saltbush, creosotebush, honey mesquite, and mountain mahogany; and woodlands dominated by pinyon and juniper (Dick-Peddie 1993, Muldavin et al. 1996).

From the GPS location of each pole, a polygon with a 3-km radius was placed around each point location. The polygon equated to a vegetation sampling area of 28 1 km^2, or 2810 ha in the GIS (ArcInfo, Environmental Systems Research Institute, Redlands, CA). This vegetation assessment area was chosen to permit inclusion of home range sizes for raptors known to nest in the area. Tabulation of vegetation cover types with a GIS was conducted using a digital version of the New Mexico Gap Analysis Project (NM-GAP) vegetation data set (Muldavin et al. 1996, Thompson et al. 1996). This digital data set provided vegetation classes mapped at 100-ha resolution with an accuracy of 77% at the most general classification (Thompson et al. 1996).

RESULTS

Pole Examination. We examined 338 decommissioned telephone-line poles of 22 different configurations on WSMR. Of the 22 configurations, four comprised 86.3% of the available decommissioned poles (Fig. 1a, b, c, d). Three configurations, consisting of 12 poles, were considered incapable of supporting raptor or raven nests because of unpaired cross-arms and overall poor condition (e.g., Fig. 1e). We located 23 box-style decommissioned telephone-line poles comprising 10 configurations on WSMR (Fig. 1f).

Orientations of decommissioned telephone-line poles were not evenly distributed, with 67.4% of 311 poles oriented east/west or northwest-southeast (Table 1). Box-style configurations were not

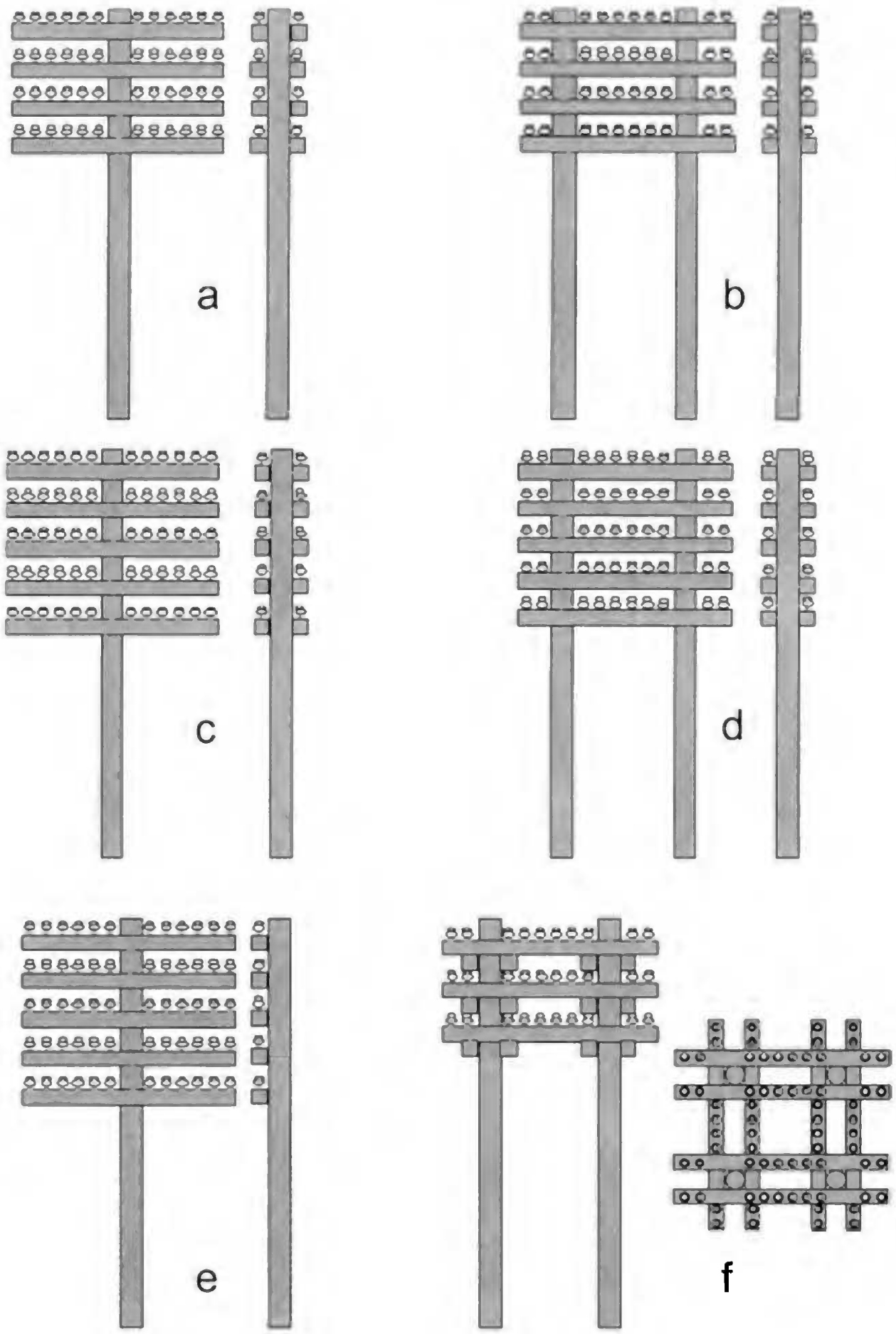

Figure 1. Examples of decommissioned telephone-line pole configurations found in the northern Chihuahuan Desert on White Sands Missile Range, New Mexico, 1997.

used in orientation and exposure analyses because these configurations were oriented in multiple directions. Dimensions of decommissioned telephone-line pole features such as distance between cross-arms, length of cross-arms, and distance between vertical poles were consistent among pole configurations. Cross-arms were 3 m long and vertically spaced 50 cm apart. Vertical poles were spaced 2 m apart in two- and four-pole configurations. Decommissioned telephone poles were 7.94–10.55 m tall with heights of cross-arms varying accordingly. No pole configuration was consistently

Table 1. Orientation of decommissioned telephone-line poles used as nesting substrates by the two most common pole-nesting species in the Chihuahuan Desert on White Sands Missile Range, New Mexico, 1997.

	ORIENTATION			
	EAST-WEST	NORTHEAST-SOUTHWEST	NORTH-SOUTH	NORTHWEST-SOUTHEAST
All poles (N = 311)	114[a] (36.6)[b]	65 (20.9)	36 (11.6)	96 (30.8)
Chihuahuan Ravens (N = 61)	21 (34.4)	11 (18.1)	7 (11.5)	22 (36.1)
Swainson's Hawks (N = 26)	12 (46.2)	4 (15.4)	4 (15.4)	6 (23.1)

[a] Number of poles having a specific orientation.
[b] Percentage of occurrence.

taller than others. Within a line of decommissioned telephone-line poles, distances between poles ranged from 4.6–1200 m.

Raptor and Raven Nests. We detected 64 Chihuahuan Raven, 27 Swainson's Hawk, three Red-tailed Hawk, and two Great Horned Owl nests among the decommissioned telephone-line poles (Fig. 2). Four Red-tailed Hawk and two Chihuahuan Raven nests were detected on electrical poles (Fig. 2). Nests on telephone-line poles were concentrated in the Tularosa Basin, while nests on electrical poles were encountered mostly on the Jornada del Muerto (Fig. 2). Subsequent analyses and discussion focus only on Chihuahuan Raven and Swainson's Hawk nests on decommissioned telephone-line pole nests.

Chihuahuan Raven Nests. Of 19 telephone-line pole configurations available as nesting platforms, Chihuahuan Ravens nested on five (Table 2). Additionally, for configurations with more than one vertical pole, raven nests were most often between vertical poles (Table 3). Also, 37.1% of raven nests were on cross-arm number two, while cross-arm number four supported 33.9% of the nests (Table 2). Mean heights of cross-arms two and four were 7.88 m (SD = 0.42) and 7.01 m (SD = 0.67), respectively.

Analysis of exposure potential for 61 Chihuahuan Raven nests (data missing for three nests) indicated orientation away from direction of prevailing wind and afternoon solar radiation. We found that 26.2%, 19.7%, and 16.4% of these nests were exposed to the east, southeast, and northwest, respectively (Table 4).

Chihuahuan Raven nests on telephone poles displayed a similar distribution among vegetation cover types and pole configurations as was present on WSMR (Table 5). Within 3 km of Chihuahuan Raven nests, honey mesquite desert scrub covered a mean of 13.3 km^2 or 48.3% of each of the 28.1 km^2 polygons around 64 poles containing Chihuahuan Raven nests (Table 5). Black grama/dropseed grassland and creosotebush desert scrub covered most of the remaining area (Table 5).

Analysis of vegetation cover types within 3 km of the four pole configurations most used by nesting Chihuahuan Ravens indicated some differences in composition between the four-cross-arm configurations and the five-cross-arm configurations. Area around 1X4 and 2X4 configurations used by Chihuahuan Ravens had fewer vegetation cover types than the 1X5 and 2X5 configurations used by this species (Fig. 3). Four-wing saltbush and black grama/dropseed grassland covered the greatest area within the 3-km radius polygons around Chihuahuan Raven nests on 1X5s compared to available 1X5s. Chihuahuan Raven nests on 2X5s had more honey mesquite desert scrub covering the area around these poles relative to all 2X5s.

Swainson's Hawk Nests. Swainson's Hawks nested on five configurations of decommissioned telephone-line poles (Table 6). Nearly half of the nests (48.2%) were on the 2X4 configuration; however, this configuration comprised 19.2% of all decommissioned poles (Table 6). Exposure potential for 26 Swainson's Hawk nests (data missing for one nest) revealed that 34.6% were exposed to the east and 23.1% were exposed to the northwest (Table 4). All Swainson's Hawk nests on telephone poles were in the Tularosa Basin (Fig. 2).

Most (66.6%) of Swainson's Hawk nests were on cross-arm two (Table 6). Mean height of cross-arm two on the 1X4 configuration was 7.54 m (SD = 0.55) and 8.27 m (SD = 0.70) for the 2X4 configuration. Swainson's Hawk nests were placed most often between vertical poles on configurations with more than one vertical pole (Table 3).

Honey mesquite desert scrub covered a mean of 18.1 km^2 or 62.8% of the area in each 28.1 km^2 polygon around poles with Swainson's Hawk nests (Table 5). Black grama/dropseed grassland con-

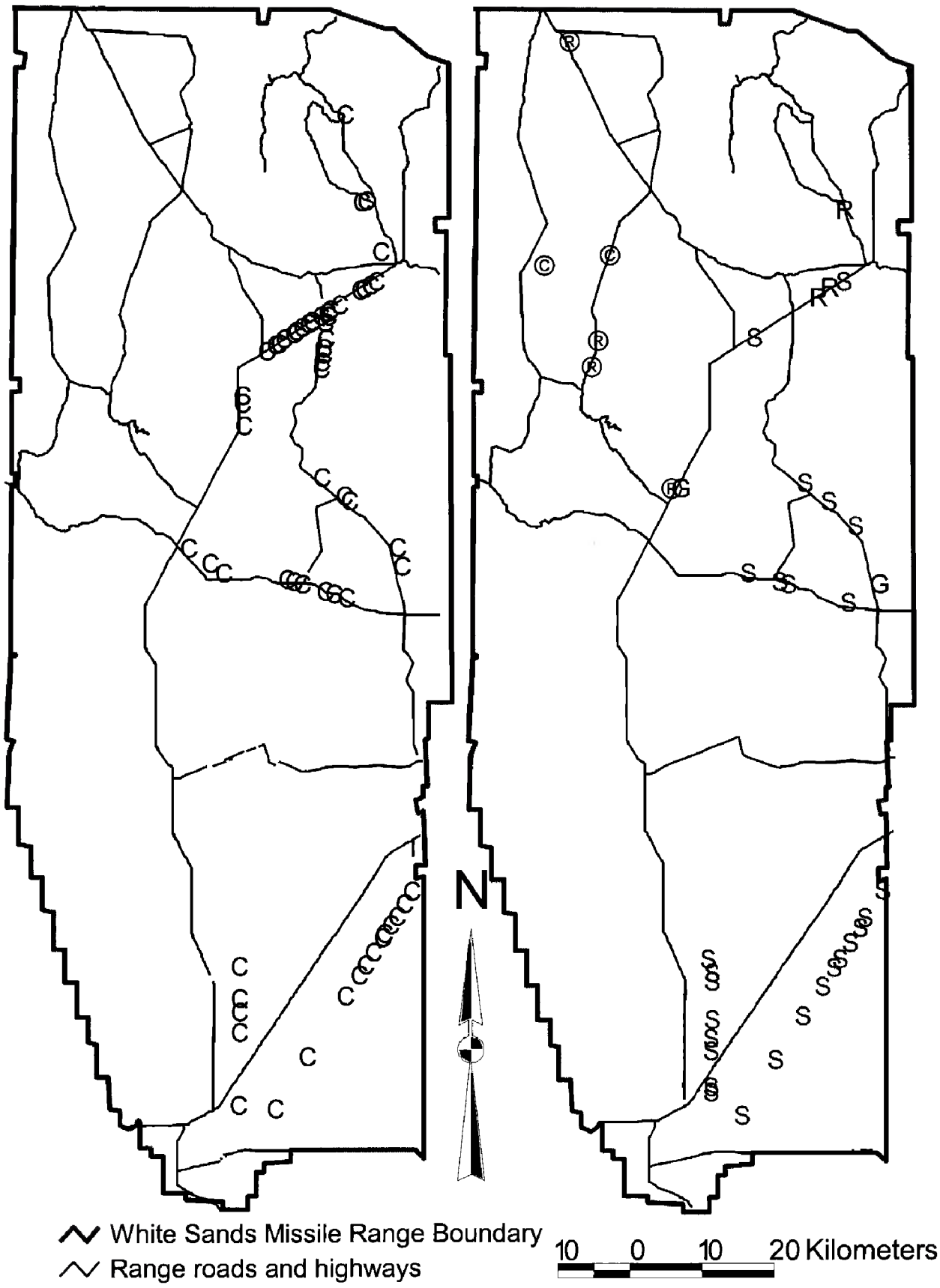

Figure 2. Distribution of Chihuahuan Raven (C), Swainson's Hawk (S), Red-tailed Hawk (R), and Great Horned Owl (G) nests on decommissioned telephone-line poles, and nests of Red-tailed Hawks ® and Chihuahuan Ravens © on active electrical transmission line poles in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

tributed 17.6% of the remaining area, or a mean of 4.8 km^2 of polygon area (Table 5).

Analysis of vegetation cover types within 3 km of the two-pole configurations most used by nesting Swainson's Hawks indicated that land-cover around the 2X4 configuration was composed mostly of honey mesquite desert scrub (Fig. 4). Additionally, land-cover within 3 km of the 1X4 configuration was more diverse than that of the 2X4 configuration (Fig. 4).

DISCUSSION

Greater use of 2X4 cross-arm configurations by Swainson's Hawks and 2X5 configurations by Chi-

Table 2. Placement of 62 Chihuahuan Raven nests among cross-arms on five decommissioned telephone-line pole configurations in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.[a]

Cross-arm No.[b]	Pole Configurations[c]					No. (Percent)
	1X4	2X4	1X5	2X5	4X22	
1	0	0	0	0	0	0
2	8	4	1	10	0	23 (37.1)
3	4	3	0	3	1	11 (17.7)
4	6	6	6	3	0	21 (33.9)
5	n/a	n/a	1	6	0	7 (11.3)
No. (%)	18 (29.0)	13 (20.9)	8 (12.9)	22 (35.5)	1 (1.6)	

[a] Although 64 Chihuahuan Raven nests were detected on decommissioned telephone poles on WSMR, data were not collected for two nests.

[b] Cross-arms are numbered from top down.

[c] Percent occurrence of these five configurations among 338 decommissioned poles: 27.8, 26.3, 13.1, 28.6, and 6.8%, respectively

huahuan Ravens suggests selection for a particular pole configuration, although we did not specifically test preference. Both configurations were interspersed with single pole configurations. Configurations with two vertical poles may provide greater protection from wind and sun exposure than would single pole configurations. Nearly all nests, either occupied or unoccupied, were inside or between the two vertical poles. Only nine nests were placed on the outside of two-pole configurations, with one nest on the outside of a box-style configuration. By contrast, 135 nests were placed inside two-pole and box-style configurations.

On portions of WSMR where prevailing winds blow in the direction of the long axis of cross-arms, nests were placed on the leeward side of the pole

Table 3. Placement of 36 Chihuahuan Raven and 17 Swainson's Hawk nests among cross-arms relative to vertical poles on three decommissioned telephone-line pole configurations in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.[a]

Cross-arm No.[b]	Nest Placement by Pole Configuration						Totals
	2X4		2X5		4X22		
	Inside[c]	Outside[d]	Inside	Outside	Inside	Outside	
Chihuahuan Raven							
1	0	0	0	0	0	0	0
2	4	0	9	1	0	0	14
3	3	0	3	0	0	0	6
4	5	1	3	0	0	1	10
5	n/a	n/a	6	0	0	0	6
Totals	12	1	21	1	0	1	36
Swainson's Hawk							
1	0	0	0	0	0	0	0
2	7	1	1	1	0	0	10
3	1	0	0	0	1	0	2
4	3	1	1	0	0	0	5
5	n/a	n/a	0	0	0	0	0
Totals	11	2	2	1	1	0	17

[a] Only configurations with two or four vertical poles are included in this tabulation.

[b] Cross-arms are numbered from top down.

[c] Represents nests placed inside or between vertical poles.

[d] Represents nests placed outside vertical poles.

Table 4. Percent of primary exposure directions among 61 Chihuahuan Raven and 26 Swainson's Hawk nests on decommissioned telephone-line poles in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

	Percent of Nests	
Primary Exposure	Chihuahuan Raven ($N = 61$)	Swainson's Hawk ($N = 26$)
North	3.3	7.7
Northeast	8.2	7.7
East	26.2	34.6
Southeast	19.7	0.0
South	8.2	7.7
Southwest	9.8	7.7
West	8.2	11.5
Northwest	16.4	23.1

relative to the origin of the winds. Nests, regardless of cross-arm, were placed against the poles in all cases, further suggesting some form of protection from wind or sun. Smith and Murphy (1982) suggested that raptor species tend to select nest sites with exposures that offer an optimum microclimate within reasonable variations. Steenhof et al. (1993) found Common Ravens nesting in the densest sections of steel electrical transmission line towers, and they speculated that nests in these sections provided better protection from high winds that caused nest destruction in other sections of the towers.

We found no nests on the topmost cross-arm on telephone poles. Mosher and White (1976) indicated that exposure of young raptors to extreme temperatures and direct sun may be a major source of thermoregulatory stress during early stages of nestling development. Schmutz et al. (1984) found Swainson's and Ferruginous hawks preferred sheltered nest platforms relative to non-sheltered platforms in Alberta, Canada. Over half of the Swainson's Hawk nests and more than a third of Chihuahuan Raven nests detected on decommissioned telephone-line poles on WSMR were on cross-arm two. This may indicate selection of a high nest platform for prey detection and predator avoidance, while maintaining some protection from exposure.

Swainson's Hawks in southern New Mexico nest in a variety of vegetation cover types. Bednarz and Hoffman (1988) reported Swainson's Hawks nesting in large honey mesquite and soapberry trees among scrub habitat in southeastern New Mexico. Pilz (1983) described the habitat of Swainson's Hawks nesting in soaptree yuccas in southern New Mexico as sparsely covered by honey mesquite; however, black grama, hairy grama, and red three-awn (*Aristida oligantha*) grasslands occurred throughout the area.

Table 5. Percentage of vegetation cover types present in the area encompassed by all 3-km radius polygons surrounding 338 decommissioned telephone-line poles and poles with Chihuahuan Raven and Swainson's Hawk nests in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

	Percent Vegetation Cover Type Among Species and Pole Status				
Vegetation Cover Types	Chihuahuan Raven Nests ($N = 64$)	Swainson's Hawk Nests ($N = 27$)	Poles With Unoccupied Nests ($N = 101$)	Poles With No Nests ($N = 140$)	All Poles ($N = 338$)
Pinyon/juniper—Closed[a]	0.1	0.1	0.00	6.6	2.8
Pinyon/juniper—Open[b]	1.1	0.9	0.8	6.1	3.1
Mountain mahogany chaparral	0.7	0.1	0.4	1.9	1.1
Four-wing saltbush desert scrub	8.1	9.5	6.4	4.4	6.0
Creosotebush desert scrub	12.4	5.0	8.1	18.1	13.2
Honey mesquite desert scrub	48.3	62.8	61.6	36.4	47.9
Blue/hairy grama grassland	0.5	0.2	0.7	1.3	0.8
Black grama/dropseed grassland	23.3	17.6	17.1	19.9	19.8
Tobosa/giant sacaton grassland	1.9	3.7	1.6	0.5	1.4
Barren/rock outcrop/playa	4.6	0.2	3.2	4.7	3.8

[a] Canopy cover >60%.

[b] Canopy cover = 25% to 50%.

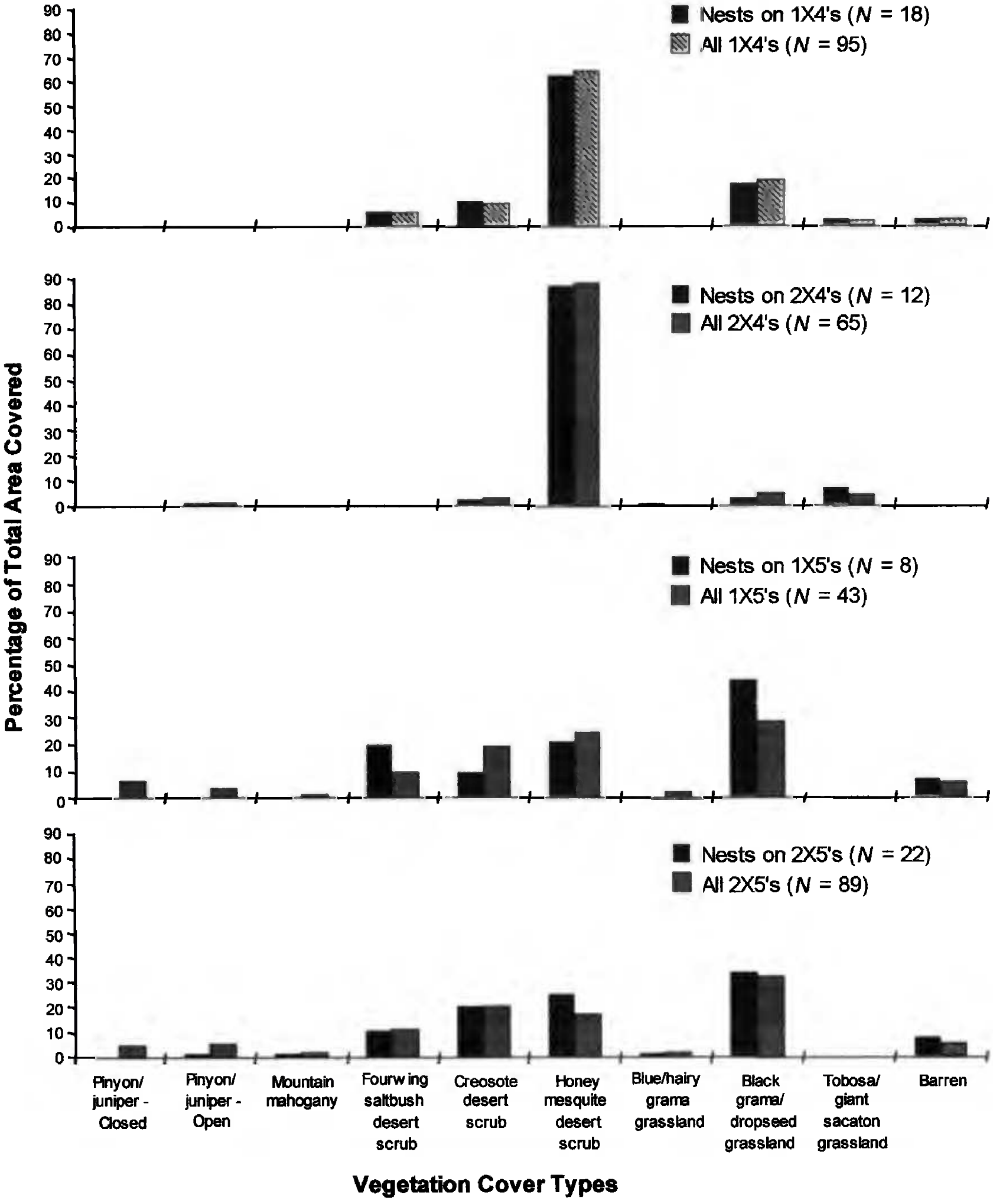

Figure 3. Percentage of total area for 10 vegetation cover types within 3-km of Chihuahuan Raven (CHRA) nests on two 5-cross-armed configurations of decommissioned telephone-line poles in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

Table 6. Placement of 27 Swainson's Hawk nests among cross-arms on five decommissioned telephone-line pole configurations in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

CROSS-ARM NO.[a]	POLE CONFIGURATIONS					TOTAL (PERCENT)
	1X4[b]	2X4	1X5	2X5	4X13	
1	0	0	0	0	0	0
2	6	8	2	2	0	18 (66.6)
3	1	1	0	0	1	3 (11.1)
4	1	4	0	1	0	6 (22.2)
5	n/a	n/a	0	0	0	0
Total (Percent)	8 (29.6)	13 (48.2)	2 (7.4)	3 (11.1)	1 (3.7)	
Percent occurrence of configuration among all poles ($N = 338$)[b]	28.1	19.2	12.7	26.3	6.8	

[a] Cross-arms are numbered from top down.

[b] Percent values do not account for 23 poles with configurations other than those included in table.

On WSMR, land cover within 3 km of all Swainson's Hawk nests on decommissioned telephone-line poles was dominated by honey mesquite desert scrub. Furthermore, land cover within 3 km of the 2X4 telephone-pole configuration was 87.4% honey mesquite desert scrub compared to 63.5% for all 1X4s along the same route. The 1X4 pole configuration was interspersed among 2X4s along routes, however, fewer of these poles were used by Swainson's Hawks as nest poles. This suggests that for Swainson's Hawks, pole configuration coupled with vegetation cover type are important features for nest site selection.

Chihuahuan Ravens nested more often on 2X4 and 2X5 configurations than on 1X4 and 1X5 configurations even though the single pole configurations were interspersed among the two-pole configurations along routes, but there were no clear differences between used and unused poles. This suggests that Chihuahuan Ravens may select poles

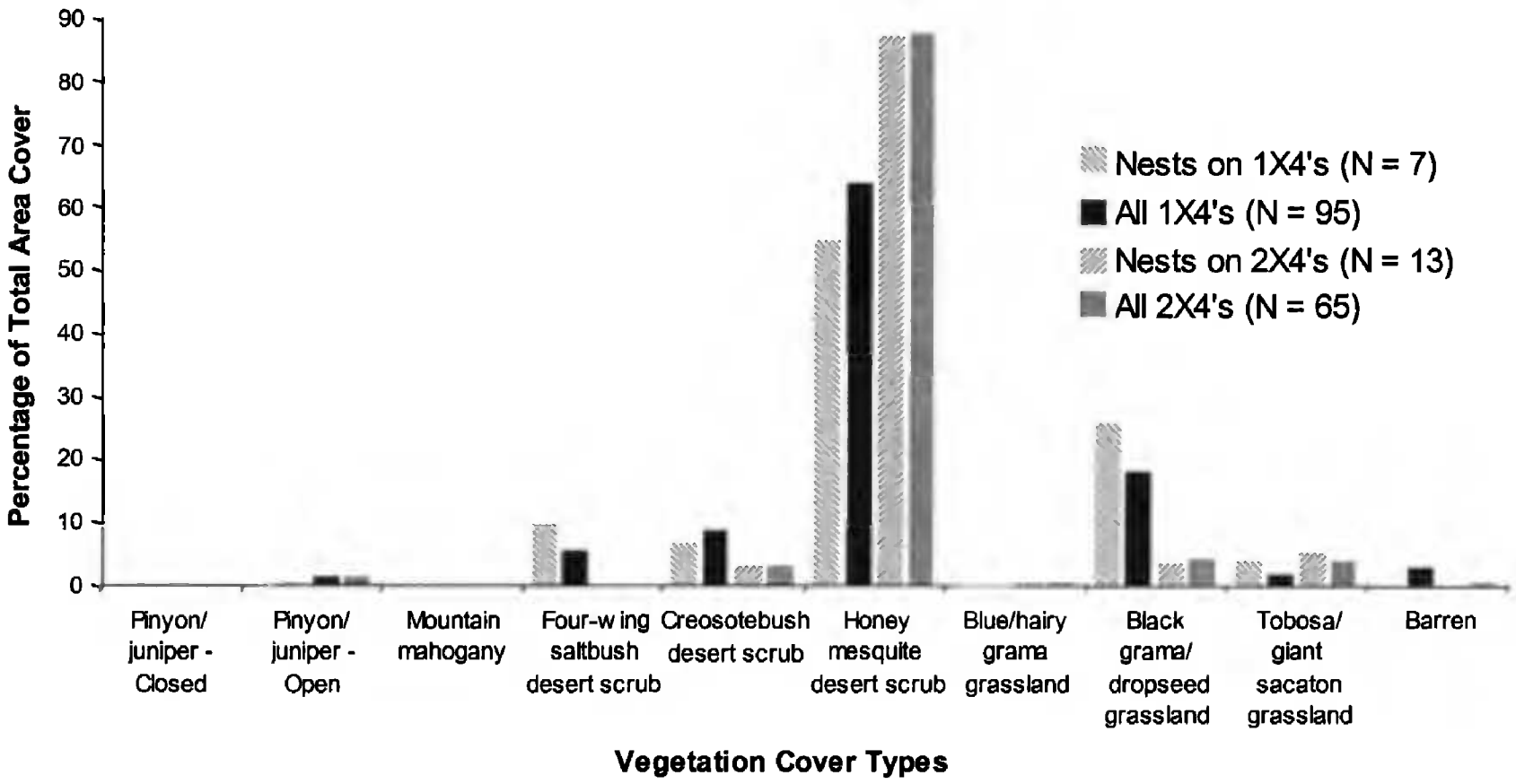

Figure 4. Percentage of total area for 10 vegetation cover types within 3-km of Swainson's Hawk (SWHA) nests on two 4-cross-armed configurations of decommissioned telephone poles in the northern Chihuahuan Desert, White Sands Missile Range, New Mexico, 1997.

based on configuration rather than the land-cover around nest poles. The two-pole configurations probably afford better protection from exposure to wind and sun.

Box-style configurations on WSMR were suitable nesting platforms for raptors and Chihuahuan Ravens, with 8–22 paired cross-arms providing a dense assortment of potential nesting platforms. The 23 box-style configurations comprised 6.8% of the total available decommissioned poles on WSMR, but they supported 4.3% of nests. Box-style configurations may not be used readily for nest placement by raptors and Chihuahuan Ravens on WSMR for three reasons: (1) density of the configuration reduces visibility for detection of predators or intruding conspecifics; (2) predators capable of climbing, such as ring-tailed cats (*Bassariscus astutus*) or bobcats (*Felis rufus*), may be more apt to climb on these configurations successfully because of the dense supportive network of cross-arms; and (3) box-style configurations had telecommunication wiring criss-crossing inside the configuration. All one and two vertical pole configurations encountered on WSMR had the wiring removed. Box-style configurations still had wiring inside, and in some instances, outside the box, thus possibly creating obstacles to flight.

We examined essentially all (>97%) of the decommissioned telephone-line poles on WSMR during 1997, thus we considered these data to represent the effective population of poles and related nests rather than a sample. Further, nest structures on poles represent nest placement that has prevailed for several years. Therefore, we interpreted directly observed characteristics of poles and surrounding vegetation as indicative of nesting associated with the population of poles that year. We have not applied statistical tests because samples were not compared. We recognize that longer-term investigation can sample several breeding seasons and draw inferences about comparisons among years. Our inferences are biologically based on extensive observation of poles and nests overall, they are not grounded in specific statistical applications. Our subsequent statements of implications should be viewed with that perspective in mind.

CONSERVATION IMPLICATIONS

Decommissioned telephone-line poles and electrical poles are acceptable nesting sites for raptors and Chihuahuan Ravens in the northern Chihuahuan Desert. Before WSMR was established, Chihuahuan Ravens, Swainson's Hawks, Red-tailed Hawks, and Great Horned Owls probably nested on natural substrates and possibly on an occasional windmill. Since introduction of telephone and electrical poles, raptors and Chihuahuan Ravens have adapted to these substrates for nesting.

This investigation focused on raptors and Chihuahuan Ravens nesting on decommissioned poles. However, other avian species including Loggerhead Shrikes (*Lanius ludovicianus*), Western Kingbirds (*Tyrannus verticalis*), and Scott's Orioles (*Icterus parisorum*) also nested on these poles. Western Kingbirds and Scott's Orioles sometimes shared the same nest structure with Swainson's Hawks. Cavities in the vertical poles, possibly excavated by breeding Ladder-backed Woodpeckers (*Picoides scalaris*), have provided nest cavities for Ash-throated Flycatchers (*Myiarchus cinerascens*) and, possibly, Elf Owls (*Micrathene whitneyi*). Like snags in forests or saguaros (*Carnegiea gigantea*) in arid landscapes, these decommissioned poles are used by a variety of migratory species in the Chihuahuan Desert on WSMR. Removal of decommissioned poles could be detrimental to the present population of raptors and Chihuahuan Ravens nesting on these poles. If poles are removed, raptor and ravens may turn to nesting on structures used for testing operations on WSMR and, thus, become vulnerable to nest disturbance. Also, other birds associated with poles and raptor nests would be displaced.

We suggest that pole-management strategies be developed and implemented by land stewards in southwestern deserts with property where pole lines remain and may be altered or dismantled in the future. Such strategies should provide for protection, maintenance, and prospective replacement of important pole structures. We found that Swainson's Hawks used 2X4 pole configurations disproportional to other configurations available. Management options for Swainson's Hawks nesting on poles likely are benefited by maintenance and retention of the 2X4 configuration as a nest platform for this species where suitable natural substrates are limited or absent.

To increase potential use of poles by birds, pole salvage operations in the southwest should strive to retain poles with two or more sets of paired cross-arms. These sets of cross-arms should be placed one above the other to provide a suitable nesting platform and shade structure for raptors and Chihuahuan Ravens.

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LITERATURE CITED

BECHARD, M.J., R.L. KNIGHT, D.G. SMITH, AND R.E. FITZNER. 1990. Nest site and habitats of sympatric hawks (*Buteo* spp.) in Washington. *J. Field Ornithol.* 61:159–170.

BEDNARZ, J.C. 1988. A comparative study of the breeding ecology of Harris' and Swainson's Hawks in southeastern New Mexico. *Condor* 90:311–323.

——— AND S.W. HOFFMAN. 1988. The status of breeding Swainson's Hawks in southeastern New Mexico. Pages 253–259 *in* R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc, Jr., B.A. Millsap, and S.W. Hoffman [EDS.], Proceedings of the Southwest Raptor Management Symposium and Workshop. Natl. Wildl. Fed. Sci. Tech. Ser. No. 11. Washington, DC U.S.A.

——— AND R.J. RAITT. 2002. Chihuahuan Raven (*Corvus cryptoleucus*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 606. The birds of North America, Inc., Philadelphia, PA U.S.A.

DAVIS, C.A. AND J.P. GRIFFING. 1977. Nesting of the White-necked Raven [Chihuahuan Raven] in southeastern New Mexico. Research Report, New Mexico State University Agricultural Experiment Station, No. 231. Las Cruces, NM U.S.A.

DICK-PEDDIE, W.A. 1993. New Mexico vegetation: past, present, and future. Univ. New Mexico Press, Albuquerque, NM U.S.A.

ENGLAND, A.S., M.C. BECHARD, AND C.S. HOUSTON. 1997. Swainson's Hawk (*Buteo swainsoni*). *In* A. Poole and F. Gill [EDS.], The birds of North America, No. 265. The Academy of Natural Sciences, Philadelphia, PA and The American Ornithologists' Union, Washington, DC U.S.A.

GRIFFING, J.P. 1974. Scissor-tailed Flycatchers and Swainson's Hawks nesting in the same tree. *Southwest. Nat* 19:111–112.

KIMSEY, B. AND M.R. CONLEY. 1988. Habitat use by raptors in south-central New Mexico. Pages 197–203 *in* R.L. Glinski, B.G. Pendleton, M.B. Moss, M.N. LeFranc, Jr., B.A. Millsap, and S.W. Hoffman [EDS.], Proceedings of the Southwest Raptor Management Symposium and Workshop. Natl. Wildl. Fed. Sci. Tech. Ser. No. 11. Washington, DC U.S.A.

MOSHER, J.A. AND C.M. WHITE. 1976. Directional exposure of Golden Eagle nests. *Can. Field-Nat.* 90:356–459

MULDAVIN, E.M., P.J. CRIST, B.C. THOMPSON, A.J. PETERS, M. EVE, B. MIDDLETON, J. EGGERTON, AND D.L. GARBER. 1996. A vegetation classification and land cover legend for application to New Mexico gap analysis. New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, NM U.S.A.

PILZ, W.R. 1983. Nesting ecology and diet of Swainson's Hawk in the Chihuahuan Desert, south-central New Mexico. M.S. thesis, New Mexico State Univ., Las Cruces, NM U.S.A.

SCHMUTZ, J.K., R.W. FYFE, D.A. MOORE, AND A.R. SMITH 1984. Artificial nests for Ferruginous and Swainson's Hawks. *J. Wildl. Manage.* 48:1009–1013.

SMITH, D.G. AND J.R. MURPHY. 1982. Nest site selection in raptor communities of the eastern Great Basin Desert. *Great Basin Nat.* 43:395–404.

STEENHOF, K., M.N. KOCHERT, AND J.A. ROPPE. 1993. Nesting by raptors and Common Ravens on electrical transmission line towers. *J. Wildl. Manage.* 57:271–281.

THOMPSON, B.C., P.J. CRIST, J.S. PRIOR-MAGEE, R.A. DEITNER, D.L. GARBER, AND M.A. HUGHES. 1996. Gap analysis of biological diversity conservation in New Mexico using geographic information systems. Research Completion Report. New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State Univ., Las Cruces, NM U.S.A.

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